WHAT IS CLAIMED IS

1. A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

forming an active device element on a substrate;

forming an insulation film over said substrate to cover said active device element;

forming a lower electrode layer of said ferroelectric capacitor over said insulation film;

forming a ferroelectric film on said lower electrode layer as a capacitor insulation film of said ferroelectric capacitor;

crystallizing said ferroelectric film by applying a thermal annealing process in an atmosphere containing a non-oxidizing gas and an oxidizing gas; and

forming an upper electrode layer on said ferroelectric film.

2. A method as claimed in claim 1, wherein said step of forming said lower electrode layer includes a step of depositing a Ti layer and a Pt layer consecutively.

3. A method as claimed in claim 1, wherein said step of crystallizing said ferroelectric film is

conducted by setting the composition of said atmosphere such that said atmosphere contains said oxidizing gas with a fraction of 1 - 50% in volume.

4. A method as claimed in claim 1, wherein said non-oxidizing gas is selected from a group consisting of Ar, He, Ne, Xe and N_2.

5. A method as claimed in claim 1, wherein said oxidizing gas is selected from a group consisting of O_2, N_2O, NO and NO_2.

6. A method as claimed in claim 1, wherein said step of crystallizing said ferroelectric film is conducted by a rapid thermal annealing process.

7. A method as claimed in claim 1, wherein said step of forming said step of forming said ferroelectric film comprises the step of forming said ferroelectric film by a sputtering process.

8. A method as claimed in claim 7, wherein

said ferroelectric film has a perovskite structure.

9. A method as claimed in claim 8, wherein said ferroelectric film is a film of zirconate titanate of Pb.

10. A method as claimed in claim 1, further comprising the step, after said step of crystallizing said ferroelectric film, of oxidizing said ferroelectric film in an oxidizing atmosphere.

11. A method as claimed in claim 1, wherein said step of crystallizing said ferroelectric film is conducted under a reduced total pressure.

12. A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

forming an active device element on a substrate;

forming an insulation film over said substrate to cover said active device element;

forming a lower electrode layer of said ferroelectric capacitor over said insulation film;

forming a ferroelectric film on said lower

electrode layer as a capacitor insulation film of said ferroelectric capacitor;

crystallizing said ferroelectric film by applying a thermal annealing process in an atmosphere of an oxidizing gas under a reduced total pressure smaller than an atmospheric pressure; and

forming an upper electrode layer on said ferroelectric film.

13. A method as claimed in claim 1 wherein said oxidizing gas is O_2 and wherein said total pressure is set in the range between 1 Torr and 40 Torr.

14. A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

forming an active device element on a substrate;

forming an insulation film over said substrate to cover said active device element;

forming a lower electrode layer of said ferroelectric capacitor over said insulation film, said lower electrode layer including a layer part containing Ti atoms;

forming a ferroelectric film on said lower electrode layer as a capacitor insulation film of said ferroelectric capacitor;

crystallizing said ferroelectric film by applying a thermal annealing process in an atmosphere of an oxidizing gas; and

forming an upper electrode layer on said ferroelectric film,

wherein said step of crystallizing said ferroelectric film is conducted by supplying O_2 controlled to cause an oxidation in said Ti atoms reached a surface of said lower electrode from said layer part containing Ti atoms.

15. A semiconductor device, comprising:

a substrate;

an active device element formed on said substrate;

an insulation film provided over said substrate to cover said active device element;

a lower electrode provided over said insulation film;

a ferroelectric film provided on said lower electrode, said ferroelectric film having a columnar microstructure extending from an interface between said lower electrode and said ferroelectric film in a direction substantially perpendicular to a principal surface of said lower electrode, said ferroelectric film essentially consisting of crystal grains having a generally uniform grain diameter of less than about 200 nm; and

an upper electrode provided on said ferroelectric film.

16. A semiconductor device as claimed in claim 15, wherein said crystal grains constituting said ferroelectric film have an average diameter of

about 150 nm.

17. A semiconductor device as claimed in claim 15, wherein said lower electrode comprises a Ti layer and a conductor layer provided further on said Ti layer.

18. A semiconductor device as claimed in claim 17, wherein said conductor layer is formed of Pt.

19. A semiconductor device as claimed in claim 17, wherein said ferroelectric film has a perovskite structure.

20. A semiconductor device as claimed in claim 19, wherein said ferroelectric film comprises a zirconate titanate of Pb.